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The Business of Education: The New Role of Education in the Globalized Knowledge Economy

Tatiana Follett
University of Denver

Libbi Levine Segev
University of Denver - Advisor

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Keywords

Education, Knowledge economy

The Business of Education: The New Role of Education in the Globalized Knowledge Economy

Tatiana Follett[1], Libbi Levine Segev[2]
[1]Student Contributor, University of Denver
[2]Advisor, Department of Business Ethics and Legal Studies, University of Denver

Abstract

The globalized knowledge economy has altered the nature of work such that employees in almost all fields and positions must have strong STEM, global competency, and critical thinking skills. A lag in the American education system has created a skills deficit for companies. Many employers report an inability to find workers with the skillset required for knowledge-economy positions. This skills deficit is detrimental to both American workers and corporations, ultimately negatively affecting the American economy. This paper uses the Programme for International Student Assessment (PISA) exam and other subject-specific data to analyze American high school students' performance in the areas of STEM, reading, global competency, and critical thinking. The data show American high schoolers perform behind their international peers and do not possess the basic skills needed for successful participation in the knowledge economy, particularly in the areas of STEM, global competency, and critical thinking. Potential solutions include Project-Based Learning (PBL) and school-business partnerships, continuing education and wage increases for STEM educators, and multidisciplinary learning. To ensure the continued success of American business, the education system will need to improve to cater to the changing workforce of the globalized knowledge economy. Failure to do so will harm students, employees, businesses, and the American economy.

1 INTRODUCTION AND REVIEW OF LITERATURE

1.1 The Knowledge-Based Economy

1.1.1 Definition and Meaning

Rapid technological development and increased trade have created a global economy and shifted industry in the United States and around the world. Technology and globalization have done more than change commerce in industry, they have also altered the way wealth and potential are valued in post-industrial economies[1]. The 'Knowledge Revolution' is ushering a "transformation from a world largely dominated by physical resources to a world dominated by knowledge"[1]. The knowledge-based economy is a trend found in advanced economies toward "greater dependence on knowledge, information and high level skills..."[2]. Thus, economic activity in post-industrialized nations, such as the United States, is changing from one that values physical, tangible assets to one that values intangible assets such as intellect, critical thinking, and knowledgebase.

1.1.2 Effects on Business and the Economy

Already as of 2006, the globalized knowledge economy was beginning to affect businesses in the United States. Companies are increasingly expanding internationally and consequentially facing a growing need for talent that can "work effectively with foreign employees and business partners" (Committee for Economic Development, 2006). According to the Committee for Economic Development's 2006 report, 58% of growth in earnings in U.S. businesses was from overseas[2]. The international growth of American earnings is an important indication that U.S. companies are becoming more global in nature. This translates to a growing need for American employees who have the skills and competencies to understand, work with, and serve a variety of cultures and populations.

Dr. Lutz, education scholar and founder of the education consulting firm LutzGLOBE, feels that the American education system is educating students based on the 20th century economy, and that American business and economy is already suffering[3]. Lutz also believes that lack of strong leadership in education and business, as well as a lack of connection between business and the education system, does not provide the connections needed for employees and employers to be successful

in the knowledge economy[3].

In a study conducted by the RAND Institute on Education and Training, business leaders expressed their ideas about the projected skills needed for current and future employees, as well as the preparedness of their employees to fill these skills.[4]. Although old, the report provides insight on how the knowledge economy was shaping, and continues to shape, the 21st century globalized knowledge economy. When 175 business leaders from 16 U.S. corporations were interviewed about the preparedness of college grads for work, many remarked that, although college grads were not prepared to handle post-graduation work, the problem stemmed from poor education in primary and secondary school[4]. Many also worried that too few students were choosing to study STEM majors, in part because their high school coursework did not prepare them for college-level STEM classes. As a whole, corporate leaders were "uncertain about whether they will be able to meet their standards for domain knowledge in entry-level employees in the future"[4].

Business leaders also felt that entry level employees did not have the critical thinking skills necessary, especially in terms of decision-making skills. Furthermore, they felt entry-level employees were ill-prepared to complete the on-the-job training required in a continuously evolving workplace[4].

1.1.3 Effects on the Job Market

Manufacturing jobs and many other blue-collar positions are moving offshore, leaving in their wake knowledge-based jobs which require a completely new skillset[5]. Historically, a high school education needed only to prepare graduates for repetitive positions, such as manufacturing, which demand a basic knowledge of science, technology, engineering, and mathematics (STEM) and minimal critical thinking skills. However, "The crucial resources…have changed from being of physical and material character…to so-called knowledge capital or intellectual capital…"[6]. Today, workers in the knowledge-economy are expected to think analytically, have a global mindset, and use STEM, especially technology, in almost all fields.

As Figure 1 illustrates, Americans believe that outsourcing is the biggest threat to American workers in the global economy. 80% of American workers found outsourcing to be harmful, more than those who find the increasing number of immigrant-workers to be harmful.

As Figure 2 shows, employment growth in the 35 years between 1980 and 2015 was 50% overall. However, 77% of employment growth was in occupations requiring analytical skills, compared to just 18% in occupations requiring physical skills. PEW defines jobs with high levels of analytical skill as those requiring "critical thinking and computer use"?.

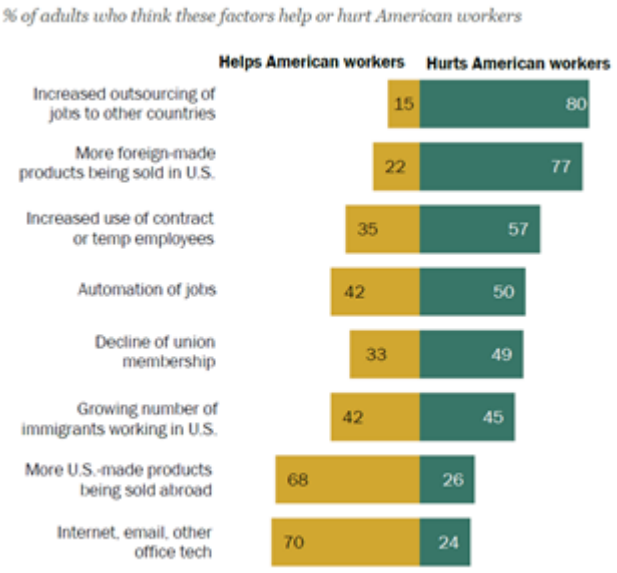

Figure 1. Global Economy Factors and Perceived Effect on Workers?

Furthermore, the manufacturing and other low-skill jobs that remain in the United States are changing due to technology improvements. Some U.S.-based companies have found that, although they would like to keep manufacturing in the United States, high school graduates are unable to handle the work. This forces companies to move their operations to countries with a more comprehensive STEM education, such as Poland: "There is a growing research suggesting that some of the new jobs…are fundamentally different from the ones that have been lost"[7]. According to global audit, financial, and consulting firm, Deloitte, the American manufacturing industry could face a skills gap of 3.5 million jobs in the next decade. The company claims that there are not enough workers "literate" in STEM to fill the requirements of employment in modern advanced manufacturing[8].

It is clear to both experts and American workers alike that the nature of work in America is changing. The skillset required of the 21st century worker is becoming fundamentally different from that required one or two generations ago. While the job market has rapidly evolved over the last decades, the education system in the United States has lagged, exposing a gap between the outdated skillset of American high-school graduates and the skillset required in a knowledge-based economy. The result of this gap is detrimental to both American workers and corporations. Unqualified American workers experience job loss and unemployment while American corporations are left with positions that they are unable to fill. To remain globally competitive, the United State education system must seek innovative reform solutions, especially in the realms of critical

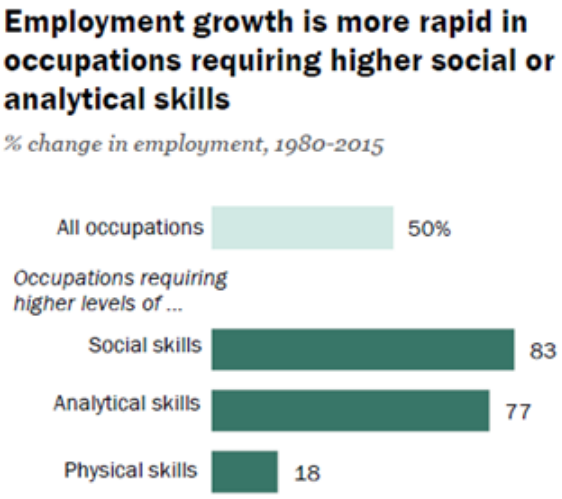

Figure 2. Employment Growth in Various Skillsets[7]

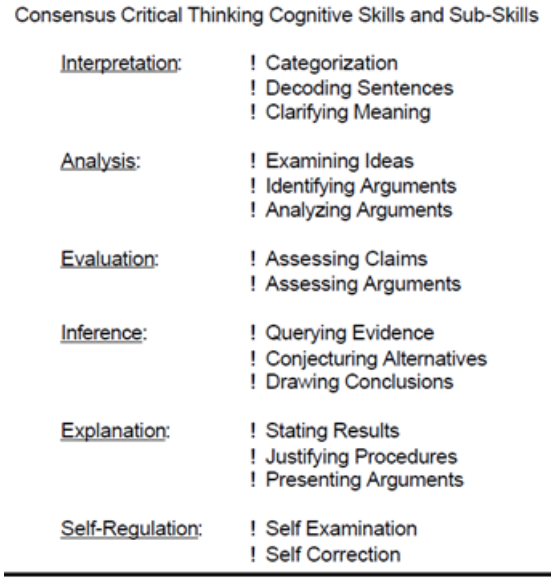

Figure 3. Five main elements of critical thinking[9]

thinking, STEM, and global competency.

2 FINDINGS

2.1 Required Skills

Technological development and globalization have played crucial roles in the development of the knowledge economy, particularly in post-industrial economies. As the nature of the economy changes, so too does the sought-after skills in the new, knowledge-based economy. While physical and tangible skills were appreciated in previous economies, the skills necessary for success in the knowledge economy are critical thinking, STEM (science, technology, engineering, and math,) information analysis, foreign language, and cultural awareness.

2.1.1 Critical Thinking

As knowledge and intellect become firms' largest assets, the need to constantly update these assets, as one would update old manufacturing equipment, becomes greater[1]. A study by the Pew Research Center in 2016 found that 45% of employed adults have taken a class or received extra training in the previous year to learn various skills necessary for their current job or for advancement in their career[?]. Critical thinking and lifelong learning are comprised of a series of skills that enable the worker to continuously improve his or her most valuable asset: knowledge. In previous eras, students in public school were taught basic skills, while those destined for more prestigious careers learned how to think in university classes: "The masses were thus taught while the future owners and managers...acquired...critical thought"[1]. This system of thinking is an outdated remnant of the industrial economy that will need to be replaced by curricula that focuses on teaching critical thinking skills at all levels of education.

As Figure 3 shows, the six main categories of critical thinking are: interpretation, analysis, evaluation, inference, explanation, and self-regulation. While this graphic was developed as a rubric for nurses in a clinical setting, it has since been frequently cited as a critical thinking evaluation framework in several fields, including education[10].

Thus, the foundational skill for workers in the knowledge economy will be the ability to continuously learn[11]. This is supported by the results of the 2018 PISA exam, which provides data on students' problem-solving skills. In particular, the 2018 PISA assessed students ability to work on problems in a group[12]. Across OECD member countries, 28% of students can only solve straightforward problem-solving skills. However, in some countries, notably China, Japan, and Singapore, 83.33% of students are skilled in collaborative problem-solving[13]. While it is important that the American education system provides basic reading, writing, and mathematics skills, it is pertinent that the system also provide the tools to enable graduates to learn and develop knowledge after compulsory school years.

2.1.2 STEM

The development of the knowledge economy and the increasing prevalence of technology in the workplace demands a working knowledge of computers and other technology. According to the Pew Research center, 85% of adults claim that competency in computer technology is important for a worker to be successful in the economy today[?]. A basic understanding of STEM, and

Skill	% Description
Basic operations and concepts	Foundational ability to use technology%
Technology productivity tools	Use of technology to aid in learning and productivity%
Technology communication tools	Use of technology to interact with peers, experts, and audiences%
Technology research tools	Use of technology to find and analyze information as well as to collect and report data%
Technology problem-solving and decision-making tools	Use of technology to develop problem-solving strategies%

Table 1 Technology skills for knowledge economy curricula[14]

Course	% of Teachers Confident in Teaching the Course
Web Design/Creation	17%
Robotics	12%
Data Analytics	11%
Graphic Design	11%
Computer Programming	8%
Engineering Design/ CAD	7%
App Design/Creation	5%

Table 2 Teacher Confidence in Teaching Technology Courses[17]

Course	% of Schools Offering the Course
Computer Fundamentals	76%
Graphic Design	66%
Enginerring Design/CAD	63%
Web Design/Creation	59%
Robotics	58%
Computer Programming	54%
App Design/Creation	35%
Data Analytics	20%

Table 3 Technology Courses offered in High Schools[17]

especially in technology, uses the ability to think critically. A solid foundation in STEM "removes traditional barriers" and allows for "innovation and the applied process of designing solutions to complex contextual problems using… technologies"[15]. In essence, it is necessary to equip all future workers, regardless of their desired career path, with the technology skills to enable them to tackle the complex, intellectual issues required of the modern knowledge worker.

While different professions will require specific technology skills, there is a set of basic skills that should be integrated into compulsory public education in the United States[14;16]. See Table 1 for a list of the basic technology skills that should be included in public school curricula.

A 2018 study conducted by PricewaterhouseCoopers (PwC) in cooperation with the Business-Higher Education Forum indicates that students do not have access to technology and/or technology courses, and teachers are not prepared to teach these courses[17]. Table 2 shows the percentage of teachers who are confident in teaching course in various technology subjects, and Table 3 illustrates technology-related classes offered at high schools.

The use and prevalence of technology in our society is increasing. Thus, the above skills, especially the use of technology to conduct research and solve problems, accompany critical thinking skills and pertain directly to employability in the knowledge economy.

2.1.3 Global Knowledge and Competency

Finally, because the knowledge economy is partially a result of decreased trade barriers and globalization, knowledge workers need cultural awareness and foreign language skills[5]. The development of global trade and the post- industrial economy have both occurred within the last 80 years, practically in tandem[18;19]. Thus, as knowledge workers have become prominent members of the American workforce, companies have become more international in nature. There are multiple education and workforce experts who cite the growing importance of foreign language and cultural awareness skills in the knowledge economy. William Kirwan, former president of the University of Maryland system, remarks that the K-12 system needs to prepare students with a "foundation in foreign languages and an appreciation of other cultures"[5]. Sandra Kerka, author of several education books, notes that "intercultural

communication" is key and "foreign language skills are becoming essential career skills"[11]. The global nature of business in the 21st century means that students need to be "learning how to think about global issues" by being able to analyze other cultures, draw "parallels" in their own communities, and learn how to communicate with groups of people who have different viewpoints[3]. In recent decades, the term cultural intelligence has come to prominence as it embodies the idea of effective assimilation and communication with other cultures. A worker with cultural intelligence can interpret or even imitate the behaviors of an individual from another culture[20]. Cultural intelligence embodies everything from knowledge of another culture to minute details such as body language (Lutz, 2019). As intercultural communication becomes easier with the aid of technology and transportation, foreign language skills enable knowledge workers to communicate with employees from other countries and cultures. Learning a foreign language also increases cultural awareness and knowledge. Recent updates in language teaching curricula have included an increased focus on the "inseparability of language and culture…"[21]. Thus, foreign language education is not only important for the development of the analytical skill but also to increase cultural awareness and intelligence.

2.2 Comparison of U.S and Competitor Country Skillsets

2.2.1 2015 Programme for International Student Assessment (PISA) Results

The following is a collection of charts and graphs illustrating American students' performance in the three main subjects tested by the PISA exam. As stated above, the PISA exam is formulated to test not only students' knowledge of each subject, but also their ability to make inferences, draw conclusions, and analyze information, which are main indicators of critical thinking ability. Therefore, the higher students score on the exam, the more they are drawing conclusions and making inferences from the data. Thus, the higher the score, the more competency students have in the subject and the better their critical thinking skills.

Science

Table 4 shows selected results of the 2015 PISA exam for science.

The United States scored a 496, around the OECD average of 493 and well below nations such as Singapore, Japan, and China. An analysis of PISA 2012 data from the National Science Foundation indicates that the United States places below 15 other OECD member countries[23].

Figure 4 illustrates the number of students that scored below a level two on the science exam from the United States and various similar and high-performing competitor countries. For reference, scoring a level two on the science section of the PISA exam requires only "low-level inferences" and "basic or everyday knowledge"[2].

Country	Mean Score
OECD Average	493
Singapore	556
Japan	538
China	529
Germany	509
United States	496

Table 4 2015 PISA Science Results[22]

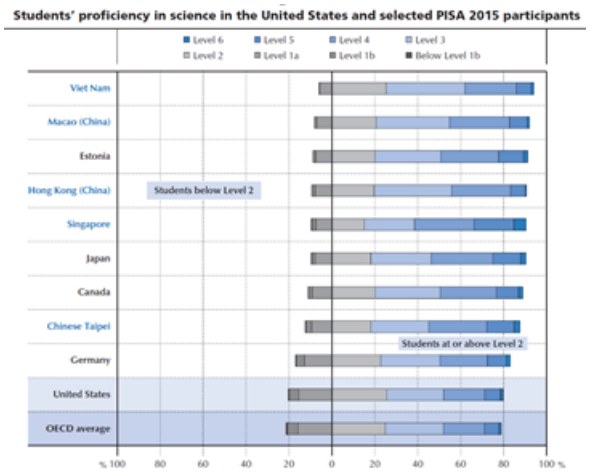

Figure 4. 2015 PISA Science Results - Selected Countries' Level 1-6 Performance[22]

Reading

Table 5 provides data for PISA reading performance.

The United States scored a 497 out of a possible 698, statistically insignificant from the OECD average of 493. For comparison Singapore, the top scoring country, earned a 535.

Country	Mean Score	95% Confidence Interval
OECD Average	493	
Singapore	535	532-538
Canada	527	522-531
Japan	516	510-522
Germany	509	503-525
China	509	506-511
United States	497	490-504

Table 5 PISA 2015 Reading Results[22]

Country	Mathematics
OECD Average	490
Singapore	564
China	544
Japan	532
Canada	516
Germany	506
Russia	494
United States	470

Table 6 2015 PISA Mathematics Scores[22]

Figure 5 shows the average three-year change among selected OECD and non-OECD countries that took the 2009/2012 and the 2015 PISA exam.

Mathematics
Table 6 provides information about selected countries' mathematics scores from the 2015 PISA exam.

As seen in Table 6, the United States score of 470 is below the OECD average of 490 and well below the scores of competitor countries such as China, Japan, Germany, and Russia. Also of statistical significance is the comparison of 2012 results with 2015 results.

The United States scores changed significantly between 2012 and 2015. American students scored over 10 points worse, on average, than in 2012. For comparison, Russia had a statistically significant increase of over 10 points between 2012 and 2015.

PISA 2018 Exam: Global Competency
In 2018, the PISA exam included testing on global competency for the first time. PISA noted that, since the Cold-War, "ethno-cultural conflicts have become the most common source of political violence in the world"[12]. In light of this, the PISA 2018 exam included a global competency section to provide data for the development of evidence-based curricula to help prepare students to tackle these global political issues. In particular, PISA felt that education systems can help students become "global citizens" by teaching how to critically evaluate information and social media platforms and encouraging an appreciation for different cultures and languages[12].

PISA tested students on global competency through two sections: a cognitive assessment and a global questionnaire[12]. PISA identified four main aspects of global competency that are important to assess: knowledge, cognitive skills, social skills and attitude, and values. Both the cognitive test and the student questionnaire tested students' knowledge and cognitive skills. The student questionnaire tested social skills and attitudes. "Values" was not assessed on the 2018 exam.

Foreign Language Instruction
In the United States, just 20% of students in primary or secondary school take a foreign language, compared to 92% of primary or secondary school students in Europe[24]. In China as of 2006, 67.4% of those with junior secondary education had studied one or more foreign languages. This equates to 32.86% of the total population[25]. Of those who had studied a foreign language, 93.8% studied English, with 21% reporting that they are able to sustain a conversation in English[25]. In contrast, only 0.67% of students taking a foreign language in the United States in the 2007/08 school year studied Chinese[26]. Furthermore, of the language classes taught in U.S. schools, 78% are introductory-level courses lacking in-depth topics requiring critical thinking[26].

The lack of foreign language proficiency in schools is already presenting itself in the business sector. In the United States, business executives speak an average of just 1.5 languages, compared to their peers in the Netherlands, who speak an average of 3.5[26].

3 ANALYSIS

3.1 2018 PISA Test Results

3.1.1 Science

As Table 4 indicates, the United States' science score of 496 is statistically insignificant from the OECD average score of 493[13]. Not only was American students' performance unremarkable, but it also fell well below the performance of a number of other nations, many of whom are direct competitors to U.S. businesses and economy. Japan, China, and Germany's scores are all higher than the United States' score. Table 4 delves further into the achievement disparity between the United States and competitor countries. The table shows the percentage of students scoring each of the proficiency levels on the science portion of the exam.. In this respect, too, the United States is similar to the OECD average and behind the performance of competitor countries.

The scores point to two main issues that will negatively affect American business and economy in the globalized knowledge economy. Secondly, as noted by the RAND Global Preparedness and Human Resources study, a weak STEM education in high school means that many college students do not have the foundation necessary to be successful in a STEM major. This is supported by the data from the National Center for Education Statistics, which finds that between 22.2% and 23.9% of STEM majors require remedial coursework[27]. When analyzed together, the PISA scores, RAND business leader study, and need for remedial STEM education in college point to a severe deficit in STEM education in the United States. This deficit is detrimen-

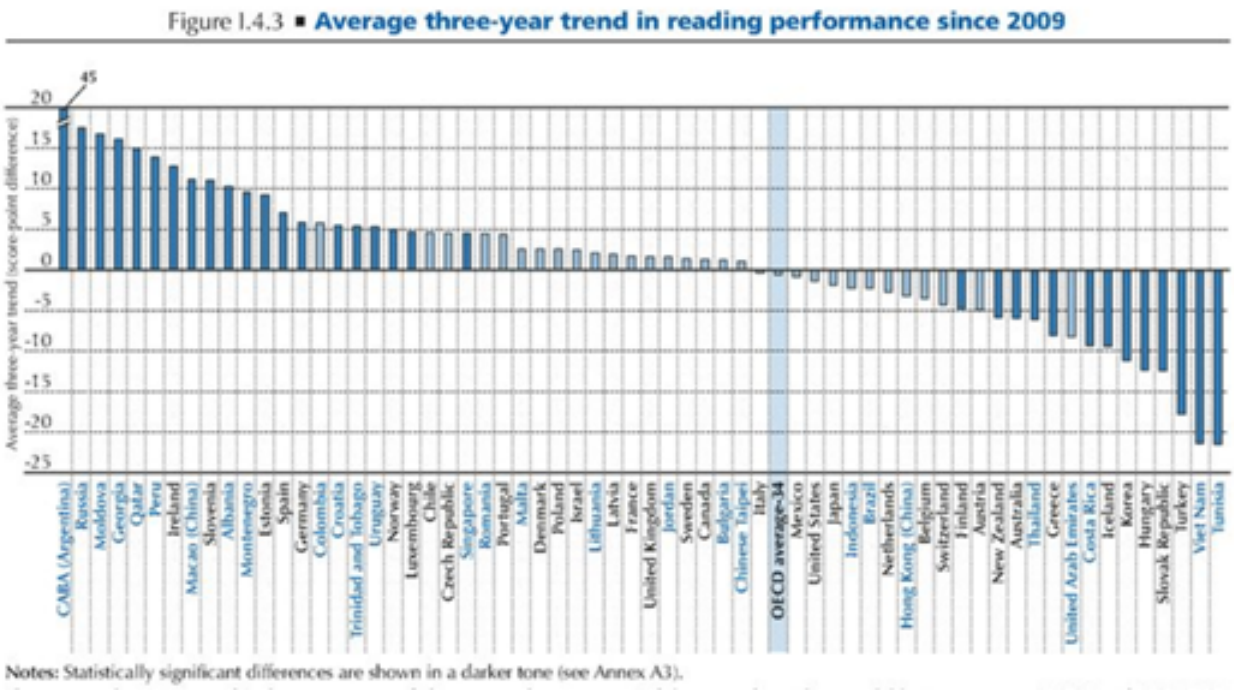

Figure 5. 2015 PISA Reading Results: Average three-year trend [22]

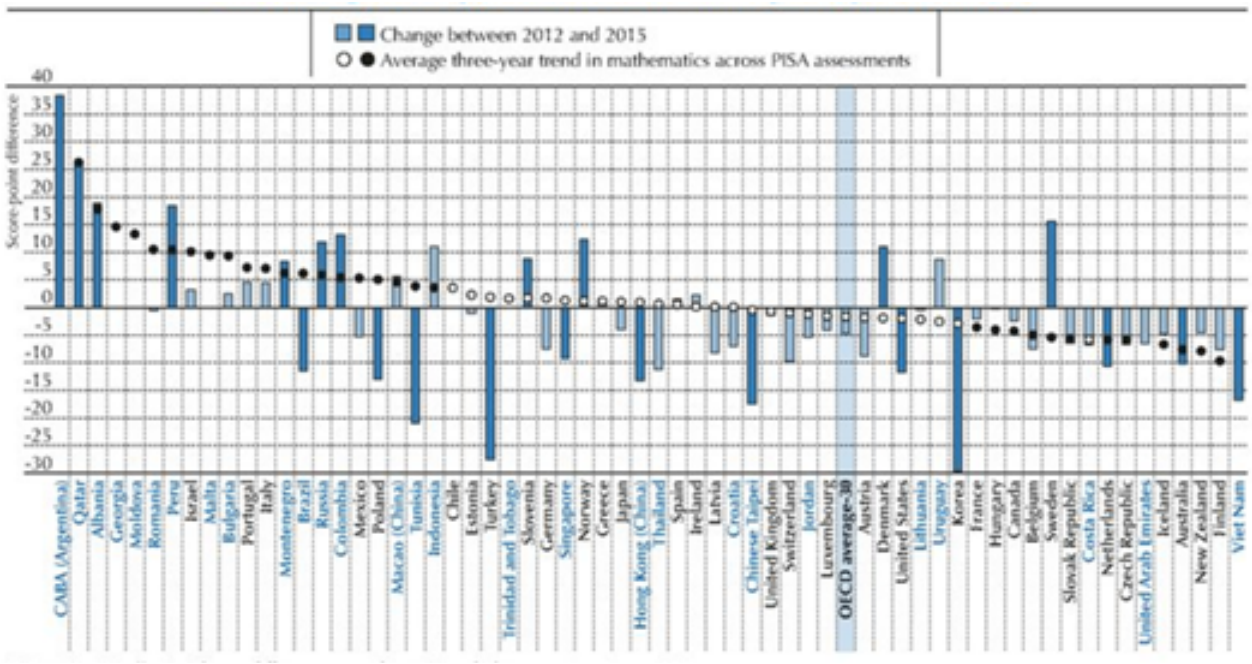

Figure 6. 2015 PISA Mathematics Scores [22]

tal to any economy, but especially so in a developing knowledge economy in which the most valued assets are knowledge and thinking skills.

3.1.2 Reading

Although reading is not often explicitly referenced as a crucial skill in the knowledge economy, and does not pertain directly to STEM education, it is a compulsory skill that enables lifelong learning. Reading functions as the foundation for learning a variety of other subjects, including STEM and foreign languages.

Figure 4 shows U.S. reading scores as compared to the OECD average and competitor country scores. Once again, American students' performance is unremarkable. In an industrialized society in which almost every career requires reading and comprehending texts, this skill is crucial. However, with the onset of the post-industrial knowledge economy, American students' lackluster performance is likely to negatively impact employability even more.

Table 5 shows the score difference, in points, between the 2012 and 2015 scores. The United States had a minor decrease in scores of around 2 points. When analyzed alone, this information is not remarkable. However, China and Russia, both developing economies and members of the widely known BRICS countries, a group of emerging economies, showed comparatively significant improvement of around 12 and 17 points, respectively (the BRIC Counties definition and synonyms, n.d.). Germany, a developed nation with a rich history of innovation and discovery, improved it's reading score by six points. Reading is a crucial aspect of learning, and constant learning is becoming crucial for employability. Thus, in order to stay competitive, the United States needs to provide a better foundation for preparing students for lifelong learning as required in the knowledge economy.

3.1.3 Mathematics

As illustrated in Figure 5, the United States' average PISA Mathematics score of 470 lies twenty points, or 4% below the OECD average of 490.

Table 6 shows the score-point difference between 2012 and 2015 scores for several OECD countries. The United States' mathematical scores showed an alarming 12-point decrease between 2012 and 2015. Other countries displayed marked improvement during the same time, indicating that the United States is starting from behind and falling even further behind in the global race to build knowledge capital. Russia showed a promising 12-point increase in scores. The mathematics data shows that American students are not learning the thinking skills necessary for work in the knowledge economy, especially when compared with students in other developed and developing nations.

3.1.4 Technology

Given the meteoric rise in technology and internet use in recent decades, it is unsurprising that the American school system is lagging in implementing both the resources and the talent to teach students the necessary skills for the knowledge economy.

As with critical thinking skills, inadequacy in technology education stems from teachers who are not prepared to teach skills needed in the knowledge economy. Students do not have access to valuable technology courses because there is insufficient talent to teach courses in these emerging industries. Figure 6 shows just how few teachers can teach technology skills. No more than 17% of teachers feel comfortable teaching a technology course, and as few as five percent feel comfortable teaching an App-Design course. In terms of technology education, American students are not just underperforming, they are not being given the opportunity to perform at all. The severe lack of teachers with technology skills indicates that teacher-education systems are outdated, and the U.S. schools are not including the necessary courses to prepare teachers for educating knowledge workers.

Unsurprisingly, American students have little access to technology courses in high school. As with science and mathematics courses, in college, it is difficult to master a subject to which the student has had no prior exposure. While a strong majority, 76%, of schools offer courses in basic computer skills, only 63% offer Engineering Design/ CAD courses, 54% offer computer programming courses, and only 20% offer courses in Data Analytics. Since 2013, demand for data scientists has risen by 344%[28]. Furthermore, data shows that the demand for data scientists exceeds the supply[28]. Students need exposure to current technology courses in high school, both to guide them to relevant post-graduate career and academic paths and to give them the necessary skill base to later master these subjects. The American education system cannot afford to stall the implementation of comprehensive, required, and relevant technology courses.

3.1.5 Critical Thinking

While limited, the data presented by the PISA exam and other sources is similar to the data for the other subjects. American students' performance is in no way remarkable and fell below the exceptional performance of main competitor countries such as China, Japan, and Singapore.

Teaching critical thinking is difficult, and often requires individualized feedback[29]. Critical thinking requires educators to teach students a methodology for thinking. Although it is possible to teach critical thinking through the instruction of other compulsory subjects, it requires educators to teach beyond rote memorization of facts and force students to contemplate

larger problems through the aid of guiding questions. However, if educators are the product of a system that does not teach a critical thinking framework, then educators will not be equipped to teach these frameworks in their own classrooms. The data show that one of the main barriers to teaching critical thinking is teachers' lack of critical thinking skillset[29]. Thus, just as future educators are trained to teach addition and spelling, they must also be trained to teach thinking.

As a whole, on their own, these scores are concerning for the United States, a country that currently leads the free economic world and is at the forefront of innovation. However, in comparison to competitor countries' performances such as China, Japan, and Germany, these scores indicate that the United States is at risk of falling behind the global race to educate workers in the knowledge economy. Failure to reform the education system will negatively impact American business and potentially jeopardize the United States' place as a global economic powerhouse.

3.2 Global Knowledge and Competency

3.2.1 International Instruction

Students well-equipped to fill the needs of American businesses in the knowledge economy need a working knowledge of the cultures and countries of the world. However, two thirds of American schools do not have the resources necessary for international education, an indication that American education system, as compared to competitor nations, is failing to prepare students for 21st century work. Test scores further support this claim. In the United States, social studies courses are dedicated to providing information about U.S. and world history, culture, and politics[30]. As the data about students' geography and social studies show, American students are severely lacking in global knowledge. According to National Geographic, locating nations on a map is a basic skill designed to be accomplished by American students in grades two through four, and one which many students have not mastered (National Geographic, n.d.). Given business leaders are looking for extensive global competency, American students shocking dismal global knowledge base is concerning[4].

3.2.2 Foreign Language

American students' nearly absent foreign language skills do nothing but reinforce the stereotype that Americans are completely inept at language. Just one in five American students take a foreign language, compared to over nine of ten European students and 67.4% of Chinese students. Beyond this, most Americans do not go beyond basic instruction, as evidenced by the facts that 78% of language courses are introductory level. Mandarin Chinese is one of the most spoken languages in the world, yet less than one percent of American students learn the language[31]. Many argue that as English has become a global language which is often used in international business and government transactions, there is no longer a need for widespread foreign language proficiency. This theory is only partially true. While English is a global language, and business and governmental transactions are overwhelmingly conducted in English, day-to-day interactions in international teams are still hampered by difference in language. American business people conducting work with an international team from Germany, for example, will still require accommodation for daily communication[32]. However, this methodology has repeatedly caused trouble, especially in foreign policy crises. During the Cold War, the American government ramped up Russian learning programs out of necessity. However, soon after the collapse of the USSR in 1991, these programs were dissolved. During the tense moments of the Russian annexation of Crimea in 2014, the American government was left scrambling for Russian speakers to aid in international relations initiatives.[32]. It is crucial for the American education system to prioritize language learning on a wider scale and to a deeper degree to ensure maximum preparedness for globalized political and economic transactions.

4 DISCUSSION

4.1 Potential Solutions

4.1.1 School-Business Partnerships

Several education scholars have promoted the idea of stronger relationships between schools and the businesses for which the graduates will work[1;3;11;33]. Unlike the industrial economy in which workers were merely the means by which the true assets, machinery, could produce goods, employees are now the assets. Similarly, just as employers used to have exact specifications for the machinery used in their production lines, employers in the knowledge economy are specific about the skills they look for in potential employees. The best way to ensure our school system is catering to these specific needs, both to prepare students and to provide a feasible talent pipeline for American businesses, is to foster a closer relationship between schools and businesses.

Project-Based and Multidisciplinary Learning

One way to do this is to introduce more "project-based learning" (PBL) into school curricula[3;12]. By presenting students with real-world projects based on collaboration with businesses, students hone a relevant skillset through "multidisciplinary" learning, wherein students confront multiple subjects and concepts in one learning environment[11]. This method also exposes students to potential, relevant careers and promotes

early connections between students and employers. Admittedly, partnerships of this kind can be difficult to foster, especially in rural communities[3]. However, the possibility of virtual relationships between schools and businesses is a viable option[3]. The other problem with this idea is that it requires individual relationships between schools and businesses, making it difficult to implement on a national scale. However, the potential for digital learning makes mass implementation more feasible. The American school system could look at the possibility of a digital course-pack containing a host of projects developed by American businesses which pertain to a variety of subjects. Although this does little to foster personal connections between students and businesses, it makes valuable headway in tailoring the students' education to the needs of the knowledge economy. Such project-based learning will also benefit students by encouraging critical thinking, particularly problem solving, and developing valuable soft skills such as interpersonal relations and time-management.

One small-scale trial of a school-wide project-based-learning program provides evidence that PBL, when combined with intensive classroom education, can enrich students' STEM knowledge, expose students to possible STEM pathways, and improve overall interest and participation in STEM[23]. It should be known that this case did not follow the students as they continued into college and post-college careers. Hence, the case has multiple limitations and should be reviewed with acknowledgement of the limited scope of the study. Nonetheless, the case shows promising results. With the help of the B-PASS grant, the STEM curriculum at José Marti MAST 6-12 Academy (JM-MAST) in Miami-Dade was reformed to include: the development of a teacher development program and real-world experiences with local business partners. Just prior to winning the B-PASS grant, JM-MAST was converted from a traditional public school to a STEM focused school. Before and after the transition, the school served neighborhood students. Facing a shortage of STEM teachers with real-world experience and insufficient laboratories and other equipment due to a lack of funding, the school sought to use the B-PASS grant to provide teacher education and to create relevant, rigorous curriculum for its students.

The new course curriculum was redesigned to include a traditional component, a lab portion to parallel classroom content, and a research portion. To prepare teachers to effectively lead students through the new coursework, professors from local colleges guided teachers through methods to teach STEM integration, problem-based learning, and hands-on learning[23]. The school then established relationships with three businesses for each of their science tracks: NASCAR for physical science, Miami Science Museum for life science, and LARC Technical Institute for math and computer science. Students interviewed during the program gave positive reviews: they expressed interest in the projects and one student remarked that she exceeded her own expectations for learning[23]. While this case is clearly not thorough enough to confirm the benefits of PBL, it and the implementation of similar programs in the future, along with reliable data, will further illuminate the benefits, and possible shortcomings, of a project-based STEM curriculum.

4.1.2 Global Knowledge and Competency

"The way that a teacher frames a topic in the curriculum can significantly shape its contribution to global competence"[12]. One example that PISA gives is asking students in a math class to apply knowledge about linear and exponential functions to population growth data[12]. This exposes students to global applications for abstract issues and helps to foster a global mindset. It is thus crucial that global knowledge discussions become commonplace outside of the context of social or international studies. To improve students' global knowledge and competency, teachers from all disciplines must commit to including international implications into their coursework. They must be willing to take abstract concepts and place them into international contexts. Globalization has ushered in an era in which global issues are relevant in all areas of study and employment, and the modern education system needs to reflect this fact.

4.1.3 STEM

One of the principle problems outlined in the data, above, is that many teachers do not have the skills or background necessary to effectively teach STEM courses to students. The issue of under-qualified teachers is a self-fulfilling prophecy. Teachers who do not have the skills to teach results in students who do not have the knowledge necessary to further their STEM education in college. This creates an even larger shortage of qualified STEM educators. To truly better the American STEM education system, this vicious cycle will need to be broken.

An option to encourage more STEM majors to pursue K-12 teaching opportunities is to increase wages for STEM educators. Paying STEM educators more than their art, language, and social studies peers recognizes the potential pay differential between STEM professionals and other professionals[33]. Oftentimes, STEM professionals with a bachelor's degree can achieve higher pay in the professional sector than similarly educated professionals in arts and humanities[33]. Recognizing this reality and accommodating for it in terms of teacher salaries could encourage STEM majors to consider a career in teaching. This option is, naturally, not perfect and has several moral, political, and practical issues. Paying STEM teachers more than their peers can easily been seen as elitist and begs the question: does paying STEM educators more send the message that their

subjects are more important and valued than other subjects? Schools pursuing this option would also need to consider the source of the funding for this type of this program. While an enticing and potentially lucrative option, it should be taken into consideration only in recognition of its serious drawbacks.

Another option to both encourage new STEM graduates to pursue teaching and to help current STEM educators become more proficient in their subjects is to develop continuing education programs for STEM educators and to increase minimum requirements to become STEM educators. Developing stringent requirements for STEM educators and providing continuing education opportunities for STEM teachers to meet the requirements creates a beneficial continuous cycle in STEM. Better qualified educators produce students who are more prepared and willing to tackle college-level STEM courses, fulfilling the need for better educated teachers and reinforcing the cycle.

As with any solution, there are potential challenges. Funding for continuing teacher education programs require extensive financial, time, and professional resources. Often, continuing education for teachers needs to be done during the school day or after school, taking away from student education or teachers' personal time. The task of providing resources for and completing these programs can often be daunting for both school districts and individual educators. However, studies have shown that teachers, and particularly STEM educators, are more effective after receiving continuing education through a well-structured program[34].

4.2 Conclusion

The nature of work and companies is rapidly changing in the growing knowledge economy and it is imperative that education systems follow suit. One marked change is the need for closer relationships and stronger communication between schools and companies. Universities have already been fostering relations with local and national companies. For example, Daniels College of Business at the University of Denver aims to incorporate real-world skills into course work by designing projects that require engagement with the community. Projects include: running a real stock portfolio, designing a digital app, and creating a business plan for a demonstrated community need[35]. However, more specialized skillsets for entry-level jobs requiring only a high school diploma extend this need to the K-12 level. Failure to implement structural change in the U.S. education system based off the needs of the companies its graduates serve, and with the flexibility to grow with the knowledge economy, will create serious economic issues within the American economy.

A major aspect for consideration is the increased interconnectedness of education disciplines. While STEM, the humanities, and language are still distinct, there is increased interaction between the disciplines. Furthermore, global competence, problem solving, and critical thinking are skills that need to be integrated into each subject area. In this respect, Project Based Learning and school-business partnerships are promising solutions for teaching in a way that integrates several subjects and critical thinking/global competence while providing a relevant education for 21st century work. It also ensures that students learn the skills that employers require to compete in the global marketplace. Whether or not PBL/ school-business partnerships become the prominent solutions for integrating coursework, schools need to investigate ways to engage students in critical thinking and global competency in every subject to fulfill employer needs and prepare students for future work. The broader implementation of critical thinking skills presents challenges for assessment. The data presented here does little to separate students' subject-matter knowledge and general critical thinking skills. Continual development of specific assessments to test the effectiveness of critical thinking components in subject-matter curricula will be crucial in the reformation of the education system.

The increased importance of knowledge capital demands businesses and schools to invest resources into the reformation of the education system. Citizens' well-being, and the state of American business and economy will require businesses to take special interest in the development of its most important asset: its people. Failure to heed the warnings of the data and reports from business leaders and international organizations will result in an American economy that is unable to perform competitively with peer nations in the knowledge economy. Educating American students is becoming more of a critical issue for businesses and citizens alike.

5 EDITOR'S NOTES

This article was peer reviewed.

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